IN THE CLAIMS

1. (Original) A manufacturing method of a semiconductor optical device comprising the steps of:

forming a layered film in which a first compound semiconductor layer, a second compound semiconductor layer and a third compound semiconductor layer are layered on a semiconductor substrate, and at least the second compound semiconductor layer comprises an Al-containing material;

etching the layered film by an etching method including at least wet etching thereby forming a three-dimensional structure having a sidewall portion in which the Al-containing material is exposed to at least part of the sidewall portion;

placing a semiconductor substrate formed with the three-dimensional structure on a plate member disposed in a crystal growing apparatus and cleaning the sidewall by introducing a halogen element-containing gas into the crystal growing apparatus; and

burying, subsequently to the cleaning step, a region adjacent to the sidewall with a crystal-grown semiconductor material in the crystal growing apparatus.

2. (Original) A manufacturing method of a semiconductor optical device according to claim 1, wherein a semiconductor material is crystallographically grown in a region adjacent to the sidewall in the crystal grown apparatus subsequently to the cleaning, thereby joining the semiconductor film to the sidewall without deteriorating the crystallinity of the semiconductor film.

3. (Original) A manufacturing method of a semiconductor optical device according to claim 1, wherein the plate member is heated and a halogen-containing gas is introduced into the crystal growing apparatus without being excited by an electromagnetic field while keeping the semiconductor substrate at a predetermined temperature, thereby cleaning the sidewall.

4. (Original) A manufacturing method of a semiconductor optical device according to claim 1, wherein the halogen element is chlorine.

5. (Original) A manufacturing method of a semiconductor optical device according to claim 1, wherein the first compound semiconductor layer is used as a cladding layer and the second semiconductor compound semiconductor layer is used as an active layer, and

the three-dimensional structure in a stripe structure.

6. (Original) A manufacturing method of a semiconductor optical device according to claim 1, wherein the layered film comprises a cladding layer and an active layer, which serve as a first core layer,

the three-dimensional structure has a stripe structure, and

in the crystal growing apparatus, a semiconductor material at least containing an InGaAlAs type material is crystallographically grown on the surface of a semiconductor substrate adjacent to the sidewall subsequently to the cleaning, thereby forming a first core layer and a second core layer having a composition different from that of the first core layer so that one end thereof is joined with a boundary of the sidewall and the other end thereof extends in a light propagating direction.

7. (Original) A manufacturing method of a semiconductor optical device according to claim 1, wherein the layered film comprises the first compound semiconductor layer as a multiplication layer, the second compound semiconductor layer as an electric field moderation layer, and the third compound semiconductor layer as a light absorption layer, and

the three-dimensional structure has a mesa-shaped structure.

8. (Original) A manufacturing method of a semiconductor optical device according to claim 1, wherein the second compound semiconductor layer comprises an InGaAlAs type material, and the manufacturing method comprises the steps of:

forming gratings to a layer containing the second compound semiconductor layer by using an etching method at least including wet etching;

cleaning the surface of the gratings with a halogen element-containing gas in a crystal growing apparatus; and

conducting crystal growing on the surface of a semiconductor substrate formed

with the gratings in the crystal growing apparatus subsequently to the cleaning step, thereby burying the gratings in a semiconductor material.

9. (Original) A manufacturing method of a buried ridge type semiconductor optical device comprising the steps of:

forming a layered film in which a first cladding layer, an active layer, and a second cladding layer are layered on a semiconductor substrate and at least the first cladding layer comprises an Al-containing material;

selectively etching a predetermined pattern region so as to decrease a thickness of the first cladding layer by using an etching method at least including wet etching, thereby forming a stripe structure having a sidewall in which the Al-containing material is exposed to part of the sidewall;

placing a semiconductor substrate formed with the stripe structure on a plate member disposed in a crystal growing apparatus, and introducing a halogen element-containing gas into the crystal growing apparatus, thereby cleaning the sidewall; and

depositing a semiconductor film in a region adjacent to the sidewall in the crystal growing apparatus subsequently to the cleaning, thereby forming a semiconductor buried film in which the semiconductor film is joined with the sidewall without deteriorating crystallinity of the semiconductor film.

10. (Currently Amended) A manufacturing method for an optical elementof an optical module ~~in which an optical element formed by the method~~ comprising the steps of: forming a layered film in which a first compound semiconductor layer, a second compound semiconductor layer and a third compound semiconductor layer are layered on a semiconductor substrate, and at least the second compound semiconductor layer comprises an Al-containing material; etching the layered film by an etching method including at least wet etching thereby forming a three-dimensional structure having a sidewall portion in which the Al-containing material is exposed to at least part of the sidewall portion; placing a semiconductor substrate formed with the three-dimensional structure on a plate member disposed in a crystal growing apparatus and cleaning the sidewall by introducing a halogen element-containing gas into the crystal growing apparatus; and burying, subsequently to the cleaning step, a region adjacent to the

sidewall with a crystal-grown semiconductor material in the crystal growing apparatus ~~according to claim 1 or any one of claims 5 to 9~~ wherein the optical element is mounted on at least a portion of a semiconductor substrate.

11. (New) A manufacturing method for an optical element of an optical module according to claim 10, wherein the first compound semiconductor layer is used as a cladding layer and the second semiconductor compound semiconductor layer is used as an active layer, and the three-dimensional structure in a stripe structure is mounted on at least a portion of a semiconductor substrate.

12. (New) A manufacturing method for an optical element of an optical module according to claim 10, wherein the layered film comprises a cladding layer and an active layer, which serve as a first core layer, the three-dimensional structure has a stripe structure, and in the crystal growing apparatus, a semiconductor material at least containing an InGaAlAs type material is crystallographically grown on the surface of a semiconductor substrate adjacent to the sidewall subsequently to the cleaning, thereby forming a first core layer and a second core layer having a composition different from that of the first core layer so that one end thereof is joined with a boundary of the sidewall and the other end thereof extends in a light propagating direction is mounted on at least a portion of a semiconductor substrate.

13. (New) A manufacturing method for an optical element of an optical module according to claim 10, wherein the layered film comprises the first compound semiconductor layer as a multiplication layer, the second compound semiconductor layer as an electric field moderation layer, and the third compound semiconductor layer as a light absorption layer, and the three-dimensional structure has a mesa-shaped structure is mounted on at least a portion of a semiconductor substrate.

14. (New) A manufacturing method for an optical element of an optical module according to claim 10, wherein the second compound semiconductor layer comprises an InGaAlAs type material, and the manufacturing method comprises the steps of: forming gratings to a layer containing the second compound semiconductor layer by using an etching method

at least including wet etching; cleaning the surface of the gratings with a halogen element-containing gas in a crystal growing apparatus; and conducting crystal growing on the surface of a semiconductor substrate formed with the gratings in the crystal growing apparatus subsequently to the cleaning step, thereby burying the gratings in a semiconductor material is mounted on at least a portion of a semiconductor substrate.

15. (New) A manufacturing method for an optical element of an optical module comprising the steps of: forming a layered film in which a first cladding layer, an active layer, and a second cladding layer are layered on a semiconductor substrate and at least the first cladding layer comprises an Al-containing material; selectively etching a predetermined pattern region so as to decrease a thickness of the first cladding layer by using an etching method at least including wet etching, thereby forming a stripe structure having a sidewall in which the Al-containing material is exposed to part of the sidewall; placing a semiconductor substrate formed with the stripe structure on a plate member disposed in a crystal growing apparatus, and introducing a halogen element-containing gas into the crystal growing apparatus, thereby cleaning the sidewall; and depositing a semiconductor film in a region adjacent to the sidewall in the crystal growing apparatus subsequently to the cleaning, thereby forming a semiconductor buried film in which the semiconductor film is joined with the sidewall without deteriorating crystallinity of the semiconductor film is mounted on at least a portion of a semiconductor substrate wherein the optical element is mounted on at least a portion of a semiconductor substrate.